

Division IV Design Considerations

Chapter IV-6 Roadside Safety

IV-6-1 Introduction

The roadside is the area beyond the shoulder. Approximately one third of all fatal highway accidents involve the roadside environment. The intent of this chapter is to discuss safety treatments that minimize the severity of an accident or injury if an errant vehicle enters the roadside.

Given the importance of the roadside environment in reducing both the frequency and severity of accidents, the focus of this chapter involves the development of a forgiving roadside. The main steps include: 1) the identification of a facility specific Design Clear Zone (DCZ), 2) the identification of hazards within the DCZ, and 3) the selection of mitigative solutions to address those hazards.

Which mitigative measures are appropriate, depends on the probability of an accident occurring, the likely severity, and the available resources to effect roadside issues. Furthermore, the possible solutions for any given location may be numerous and, as such, some benefit/cost analysis may be required, in order to select an appropriate measure.

IV-6-2 Definitions

clear zone – The total roadside border area, beginning at the edge of the traveled way, available for use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The clear zone cannot contain a critical fill slope.

curb – The redirection capabilities of typical curb are minimal.

Design Clear Zone – The minimum target value used in highway design.

hazard A side slope, a fixed object, or water that, when struck, can result in unacceptable impact forces on the vehicle occupants or place the occupants in a hazardous position. A hazard can be either natural or manmade.

traveled way – The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

barrier terminal – A crashworthy end treatment for longitudinal barriers that is designed to reduce the potential for spearing, vaulting, rolling, or excessive deceleration of impacting vehicles from either direction of travel. Beam guardrail terminals include anchors.

Controlled Releasing Terminal (CRT) post – A standard length guardrail post that has two holes drilled through it so that it will break away when struck.

crashworthy – A feature that has been proven acceptable for use under specified conditions, either through crash testing or in-service performance.

guardrail transition – A section of barrier used to produce a gradual stiffening of a flexible or semi-rigid barrier as it connects to a more rigid barrier or fixed object.

impact attenuator system – A device that acts primarily to bring an errant vehicle to a stop at a deceleration rate tolerable to the vehicle occupants or to redirect the vehicle away from a hazard.

longitudinal barrier – Traffic barrier oriented parallel or nearly parallel to the roadway. The purpose is to contain or redirect errant vehicles. Beam guardrail, cable barrier, bridge rail, and concrete barrier are longitudinal barriers. Longitudinal barriers are categorized as rigid, unrestrained rigid, semi-rigid, and flexible. They can be installed as roadside or median barriers.

traffic barrier – A longitudinal barrier, including bridge rail, or an impact attenuator used to redirect vehicles from hazards located within an established Design Clear Zone. Traffic barriers are used to prevent median crossovers, errant vehicles from going over the side of a bridge structure, or (occasionally) to protect workers, pedestrians, or bicyclists from vehicular traffic. Barrier heights vary depending on vehicle speed...

IV-6-3 Design Purpose and Need

It is the charge of all public agencies to ensure the safe and efficient function of public roadways within the transportation system – regardless of jurisdictional hierarchy. The inclusion of roadside safety, as an element of design, is currently a common practice, but it is also critical in meeting the safety needs of the traveling public.

IV-6-4 Balancing Considerations

Roadside safety requires the consideration of the available clear area and the identification of hazards within the desired clear area. Guidance within WSDOT's *Design Manual* calls for the evaluation of the Design Clear Zone (DCZ) to determine the adequacy of the existing clear area and to identify where modifications to the roadside are necessary in order to achieve improved safety. The *Design Manual* uses the DCZ Table¹ to define the DCZ. The table considers speed, traffic volumes, and adjacent slopes, in determining DCZ values.

Following the establishment of the desired clear area, an identification of any potential hazards within the clear area needs to occur. There are three general categories of hazards: side slopes, fixed objects, and water.

Mitigate hazards that exist within the Design Clear Zone (DCZ), when feasible. In addition, consider mitigation of other hazards that exist beyond this area. In particular, consider the accident history and context of the roadway when evaluating what hazards require mitigation, recognizing that the accident history and context may dictate that hazards outside of the DCZ would be appropriate for mitigation.

Side Slopes

Side slopes are either fill slopes or cut slopes. Fill slopes can present a hazard to an errant vehicle, with the degree of severity dependent upon the slope and height of the fill. Providing fill slopes that are 4H:1V or flatter

¹ WSDOT *Design Manual* Chapter 700

can mitigate this hazard. If flattening the slope is not feasible or cost effective, the installation of a barrier might be appropriate. The WSDOT *Design Manual* contains additional information on determining whether or not a fill slope is a hazard.

A cut slope is usually less of a hazard than a traffic barrier. The exception is a rock cut with a rough face that might cause vehicle snagging rather than providing relatively smooth redirection.

Fixed Objects

Consider the following objects for mitigation (this list is not all inclusive):

- Wooden poles or posts with cross sectional area greater than 16 square inches that do not have breakaway features
- Non-breakaway steel sign posts,
- Non-breakaway light standards;
- Trees having a diameter of 4 inches or more measured at 6 inches above the ground surface;
- Fixed objects extending above the ground surface by more than 4 inches (for example, boulders, concrete bridge rails, piers, and retaining walls);
- Existing guardrail that is not up to current design level;
- Drainage items, such as culvert and pipe ends;
- Mailboxes located within the DCZ, which do not have the appropriate supports and connections; and
- Open culvert ends located on a roadway side slope, within the DCZ.

Figure V-6.1 – Fixed Objects in Clear Zone



(Source: Bridgeport Way, Lakewood, WA and SR 14, Stevenson, WA)

Water

Water may be a hazard when it has a depth of 2 ft or more and is located within the clear area. Mitigation for this type of hazard is evaluated on a project-by-project basis. Consider the length of time traffic is exposed to this hazard and its location in relationship to other highway features such as curves.

Hazard Shielding

Once the appropriate Design Clear Zone has been selected and all obstacles that are potential hazards have been identified, project proponents need to consider mitigative measures from the following menu (in order of preference):

- 1) Removing obstacles
- 2) Relocating obstacles
- 3) Making obstacles crashworthy
- 4) Shielding obstacles
- 5) Delineating obstacles

If the obstacle cannot, or is not desired to be removed, relocated, or made crashworthy (for physical or economic reasons), the obstacle is to be shielded. There are numerous options for shielding, however, two main types are generally used – longitudinal and attenuating.

Figure V-6.2 – Hazard Shielding

(Source:)

Longitudinal Barrier

It is important to recognize that barriers themselves are hazards (which is why “Shielding” is ranked 4th in priority for hazard mitigation). Use of a barrier is intended to shield the hazard(s) while 1) using the most forgiving barrier possible and 2) keeping it as far away from the traveled way as possible. These two goals address both the probability of hitting the barrier and the severity of the accident.

Some common types of longitudinal barrier are concrete, guardrail, and cable barrier. These barrier types are used for many different purposes and some basic criteria exist for selecting between them. Concrete is used in situations where the roadway requires a very strong, low maintenance barrier. If less strength is required and maintenance is less of a concern, guardrail or cable barrier provide a suitable option for shielding the hazard. Cable barrier may, however, deflect a significant distance in an accident (up to 12 feet). Although this characteristic may limit its use, cable barrier is a more forgiving barrier; the resultant accident severity, when the barrier is struck, will likely be less than with other barrier types. For more information on barriers see the *Design Manual* Chapter 710.

Attenuators

Attenuators are generally used to shield obstacles that are located between traveled ways or very near to the traveled way. Like longitudinal barriers, there are a number of different types of attenuators (also known as crash cushions). Attenuators vary in size in order to accommodate different design speeds. For more information on impact attenuator systems see the *Design Manual* Chapter 720.

IV-6-5 Application of Considerations

Over the course of time, most roadways change in purpose, speed, traffic characteristics and many other variables along the length of the facility. In addition, roadside conditions also change. Given these variations, accident likelihood and severity will also vary. It is therefore appropriate to expect the level of roadside safety expenditure and design effort will vary, given the unique characteristics of a roadway.

From a roadside safety perspective, the ideal highway has roadsides and median areas that are flat and unobstructed by hazards. Although many roadways have some available clear area along the roadside for errant vehicles to recover, roadways often can benefit from more.

The constraints of an urban setting oftentimes do not allow for this ideal scenario. The urban environment will likely exhibit different characteristics – businesses up to the street, main street beautification treatments, transit facilities, street furniture, sidewalk cafes, and other similar treatments. These treatments may assume the form of fixed objects. This presents a difficult challenge between balancing safety needs for a multitude of users with the aesthetic desires of a community. Project proponents need to explore opportunities to either address both needs or communicate the need to pursue one direction over the other to users and other stakeholders. The solution in these cases is to optimize benefits to the extent possible. It will be necessary to make tradeoff decisions in these efforts.

IV-6-6 Governing Regulations and Directional Documents

Bridge Design Manual, WSDOT, M 23-50.

City and County Design Standards (*Local Agency Guidelines*, Chapter 42, WSDOT, M 36-63).

Dangerous Objects and Structures as Nuisances, Revised Code of Washington (RCW) 47.32.130.

Design Manual, WSDOT, M 22-01.

Jurisdiction, Control, RCW 47.24.020.

Limited Access Facility, RCW 47.52.010.

A Policy on Geometric Design of Highways and Streets, 4th ed. (Green Book), American Association of State Highway and Transportation Officials (AASHTO), Washington, D.C., 2001.

Roadside Manual, WSDOT, M 25-30.

Standard Plans for Road, Bridge, and Municipal Construction, WSDOT, M 21-01.

Task Force for Roadside Safety, *Roadside Design Guide*, AASHTO, Washington, D.C., 2002.

Traffic Manual, WSDOT, M 51-02.

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